FISKERIDIREKTORATETS SKRIFTER
SERIE HAVUNDERSØKELSER

Reports on Norwegian Fishery and Marine Investigations
Vol. 13, No. 4, 1962

A Pressure Aquarium for Experimental Use

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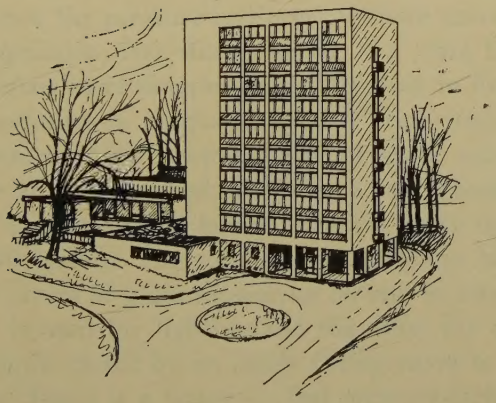

BERGEN 1962

In experimental aquatic science the hydrostatic pressure is frequently a point of interest. In the past most studies have been carried out under natural conditions at the appropriate depths. While some aquaria have been constructed for use at increased pressures, the criteria of constant pressure of the dissolved gases, continuous flow of water through the vessel, constant hydrostatic pressure and a noncavitating pump system have not been met.

Fig. 1 shows a simple pressure aquarium designed by the author. It is constructed of stainless steel and has a volume of 360 liters. In order to increase the pressure resistance without unduly adding to the weight of the aquarium, five steel rings ($1 \times 1''$) are fitted around the 5 mm thick stainless steel pressure tank as shown in Fig. 2.

The water pressure is produced by a 1″ centrifugal pump fed by water at a pressure of five meters. The pressure valve at the outlet contains a series of springs which allow for a continuous pressure variation from 0—100 meters to be made. A safety valve opens if the pressure exceeds 100 meters. The side of the aquarium has two windows made of double layers of glass measuring 36 mm in total thickness. One of the windows is used for lighting and the other for observation. The opening at the top is closed by an inside fitting cover to prevent leakage at high pressure. There is a water — and pressure-tight connection for wires connected to measuring units within the aquarium.

Due to the nature of the biological problems to be studied, no supersaturation of gases in the water was allowable. As it was possible that some cavitation could occur in the pump and thereby cause supersaturation, a series of oxygen analyses were made at controlled temperatures and salinities. It was found that, by supplying the pump with water at a pressure of five meters, no supersaturation of the water in the

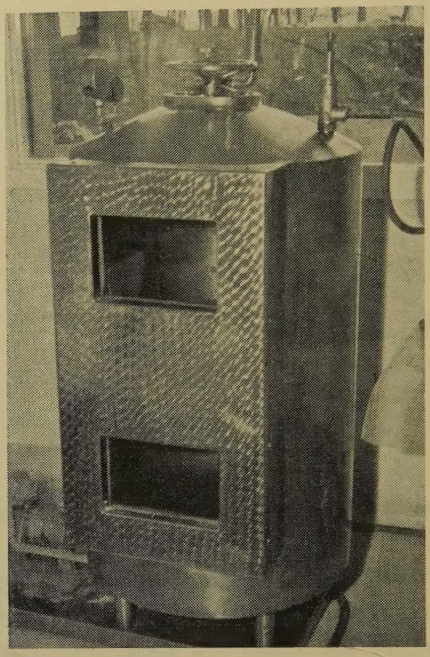

Figure 1. Picture of the pressure aquarium.

aquarium took place. Fig. 3 shows the oxygen saturation of the aquarium water plotted against the "depth"i.e. pressure.

The water through-flow and its relation to the "depth" in the aquarium is also of importance as it limits the size or number of the animals that can be maintained in the tank. In Fig. 4 the values for the minute volume are plotted against "depth". These flow-through rates allow for animals weighing up to 2 kg to be kept in the aquarium at pressures corresponding to a depth of 100 meters (Sundnes 1957).

From the data that has been obtained it seems, therefore, that this aquarium reproduces the conditions in the sea at the pressures that can be produced, except for the factor of space.

The pressure aquarium has made it possible for a number of physiological experiments to be carried out at 100 meters "depth". The function of the swimbladder and embolic diseases have been investigated. The activity of the heart and the mouth-gill ventilation in relation to "depth" have also been studied. In Fig. 5 electrocardiograms are shown from a cod (*Gadus callarias L.*) at 3 and 100 meters "depths". From the diagrams the frequency of the heart beats and the mouth-gill ventilation can be seen. The results indicate that these functions are seemingly independent of the hydrostatic pressure.

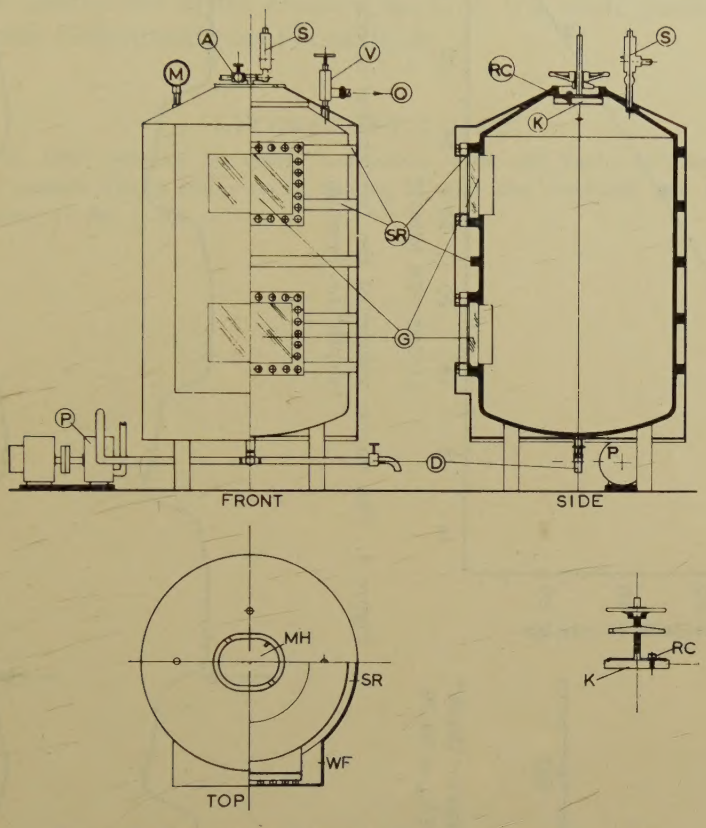

Figure 2. Construction drawings of the pressure aquarium.
A — air outlet, S — safety valve, opening at 10 atm. M — manometer, V — variable pressure valve, O — outlet, SR — steel rings, G — glass windows, P — pump, D — draining valve, RC recorder contact, K — cover, MH — opening into tank, WF — window frame of 35 × 35 mm steel.

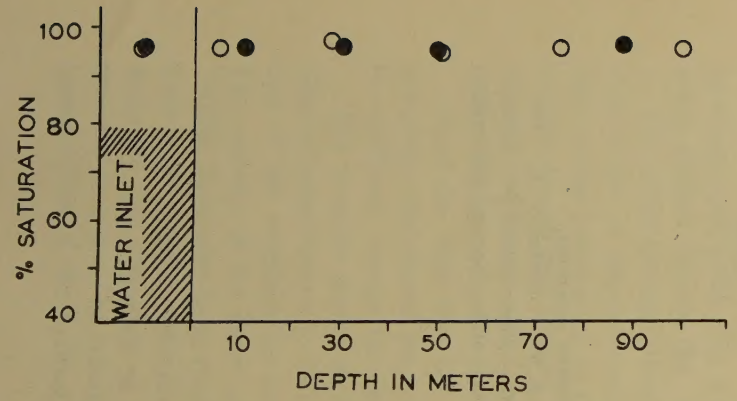

Figure 3. The oxygen content in the aquarium in relation to "depth" i.e. pressure. ● t = 8.8°C, S ‰ = 34,76. o t = 9.5°C S ‰ = 34.79

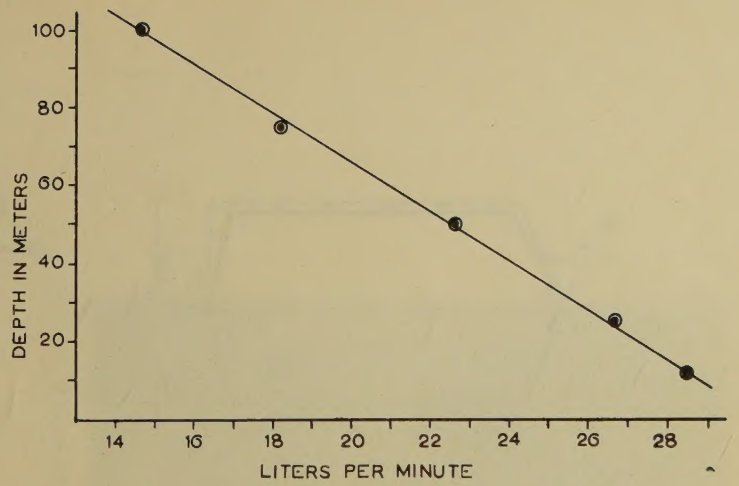

Figure 4. The minute volume of the through-flow in relation to "depth" i.e. pressure.

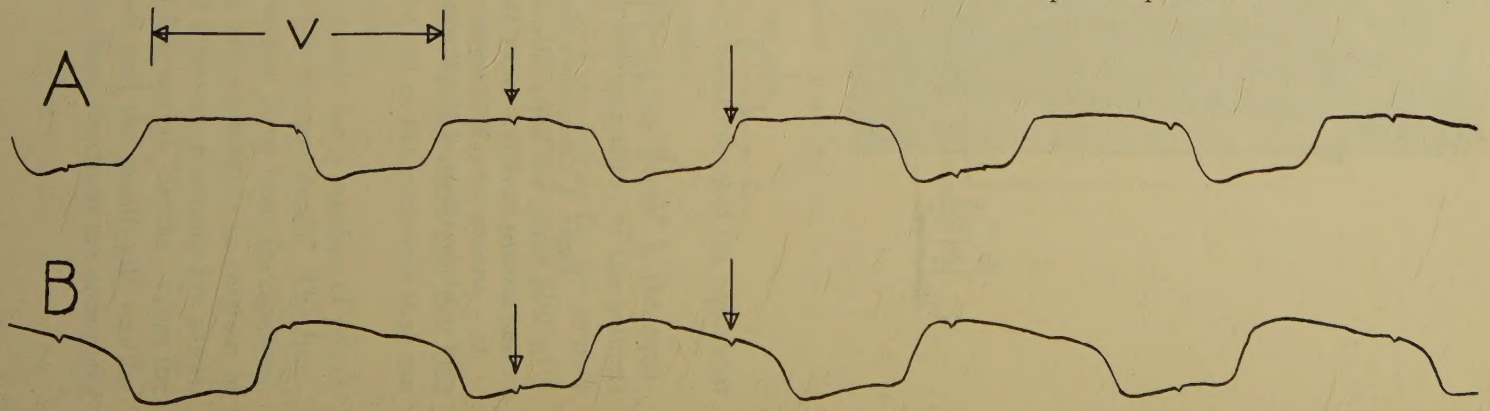

Figure 5. A — electrocardiogram from a cod (*Gadus callarias*) at a "depth" of 3 meters.

I am greatly indebted to Mr. O. Iversen, University of Oslo, for technical collaboration and to the workshop of Dalsøren—Ødegaard & Co. The construction of the pressure aquarium was made possible by a grant from Fiskerinæringens Forsøksfond.

LITERATURE CITED

Sundnes, G., 1957. Notes on the energy metabolism of the cod (*Gadus callarias L.*) and the coalfish (*Gadus virens* L.) in relation to body size. *Fiskeridir. Skr. Ser. Havunders.* 11 (9): 1—10.